Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Numerical study on the behavior of a microbubble encapsulated by hyperelastic membrane in the ultrasound field YUNQIAO LIU, Department of Mechanical Engineering, The University of Tokyo, KAZUYASU KAZUYASU SUGIYAMA, SHU TAKAGI, YOICHIRO MATSUMOTO — The surface stability problem of a microbubble encapsulated by a neo-Hookean hyperelastic membrane is numerically addressed. To predict this nonlinear behavior, the continuity equation and the Navier-Stokes equation are directly solved by means of the boundary-fitted finite-volume method on an orthogonal curvilinear coordinate system. The force balances of the membrane are derived from the traction jump condition, coupling with the in-plane tensions and transverse shear tension. The bubble is insonified by an ultrasound pulse at frequency of 1MHz and consisting of a burst of 10 cycles. The strain-softening features are presented referring to a linear model based on the Rayleigh-Plesset equation. For small acoustic amplitude, the result based on the neo-Hookean model is in good agreement with that on the linear model. With the increasing of oscillatory amplitude, the neo-Hookean membrane bubble shows an enhanced strain-softening effect – larger expansion, smaller contraction and higher harmonics during contraction. In addition, the neo-Hookean membrane bubble presents second-order shape instability. At the same time, this second-order mode shows subharmonics characteristics, which is considered as a potential medical application for ultrasonic imaging.

Yunqiao Liu
Department of Mechanical Engineering, The University of Tokyo

Date submitted: 07 Aug 2009 Electronic form version 1.4